Reducing Driftable Fines in Aerial Application of Pesticides – A Reverse Venturi Atomization Chamber

By

Russ Stocker

Norman Akesson

William Peschel


N8347K
RESTRICTED

Reducing Driftable Fines in Aerial Application of Pesticides – A Reverse Venturi Atomization Chamber

By

Russ Stocker

Norman Akesson

William Peschel

Funding:

USDA
Small Business Innovation
Research Grant

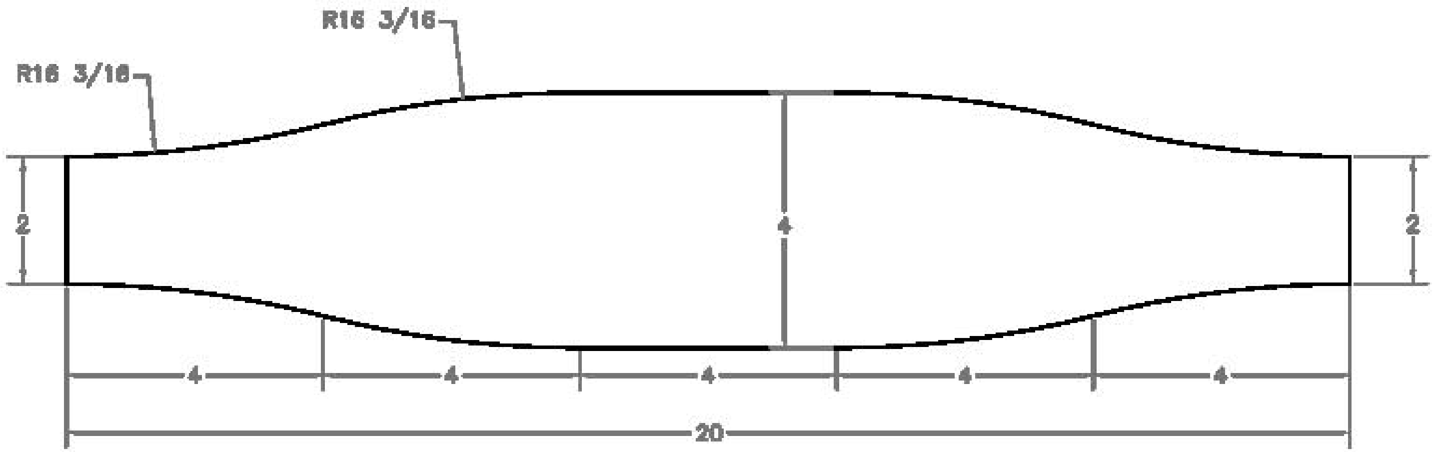
Table 1 Critical air velocity at which droplets break up

Critical Velocity, (km/h / mph)	Drop Size (microns, μ)
80.5 / ~ 50 mph	1500
105 / ~ 65 mph	900
137 / ~ 85 mph	535
161 / ~ 100 mph	385
241 / ~ 210 mph	170

Example 1 Comparison of two nozzles under the same conditions at three airspeeds. Both nozzles are oriented at 0 degrees to the air stream and operated using water at 40 psi. The key criteria predicting off-site drift is the percentage of droplets in the < 200 μ range.

flat fan nozzle	**% volume of droplets < 200 μ / % increase over previous speed**		
	50 mph	100 mph	150 mph
8010	7.54 / reference	10.47 / 2.9	29.25 / 18.8
8020	5.42 / reference	8.41 / 3.0	26.83 / 18.4

Air flow →



Reverse Venturi Atomization Chamber

Chamber 1

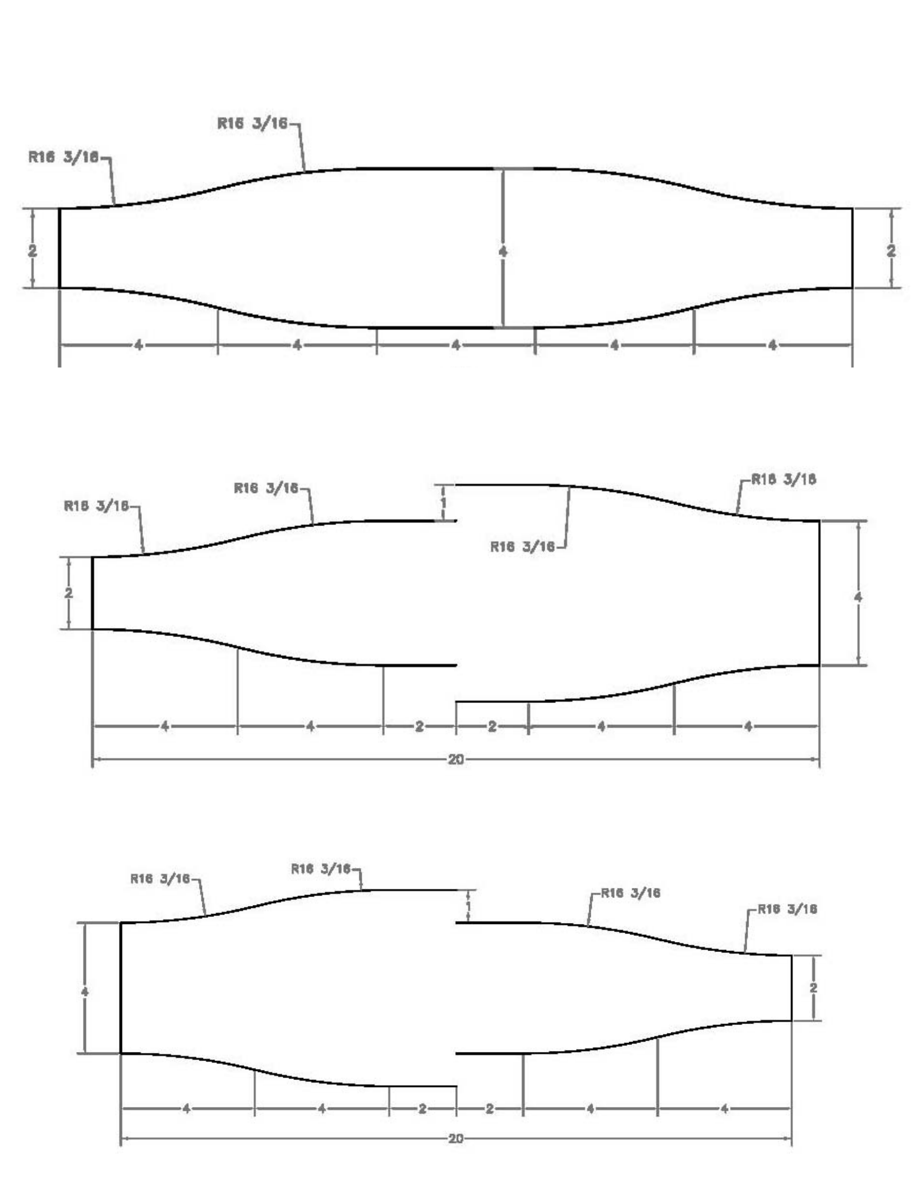
Air flow →

Chamber 2

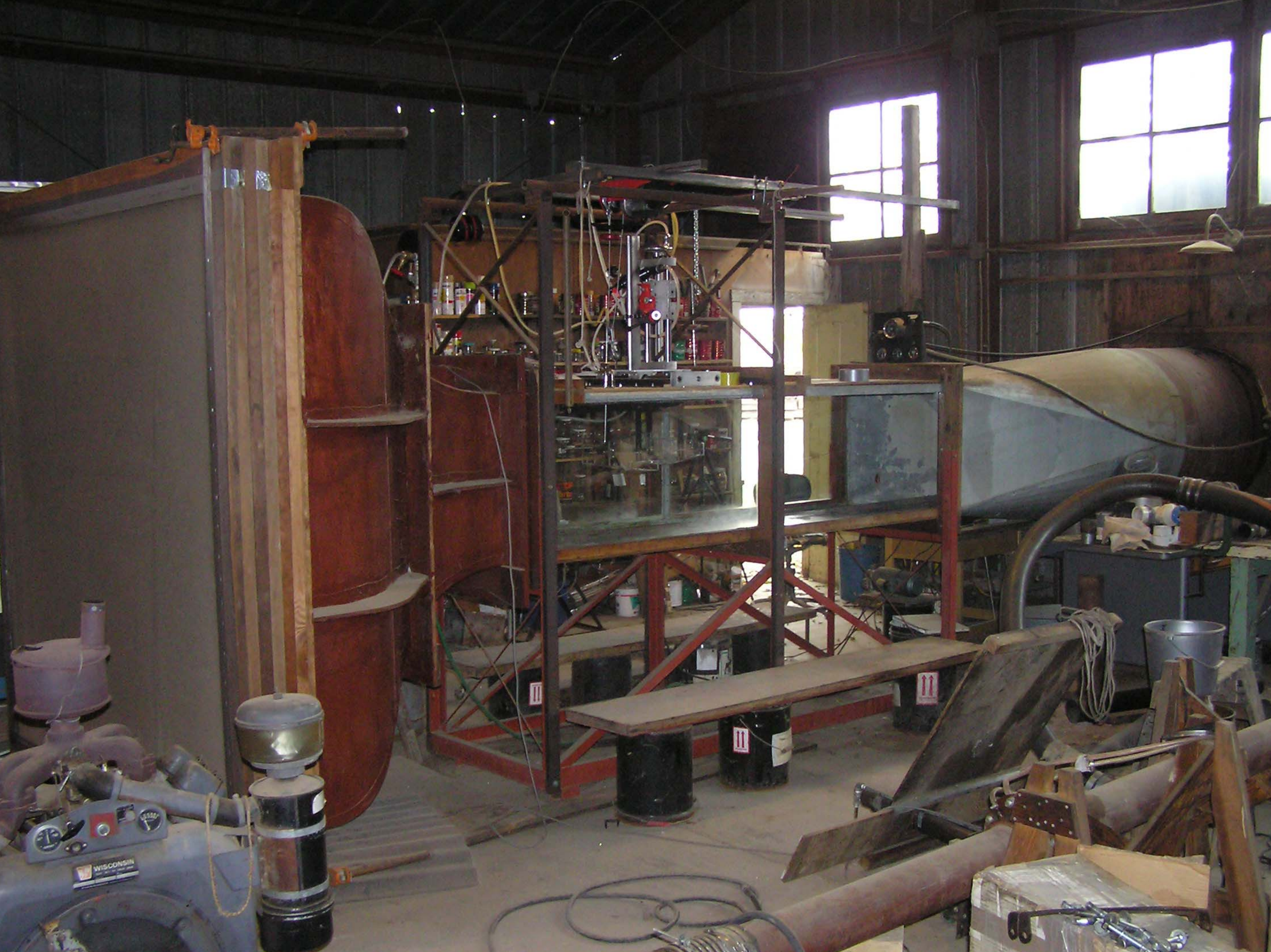
Air flow →

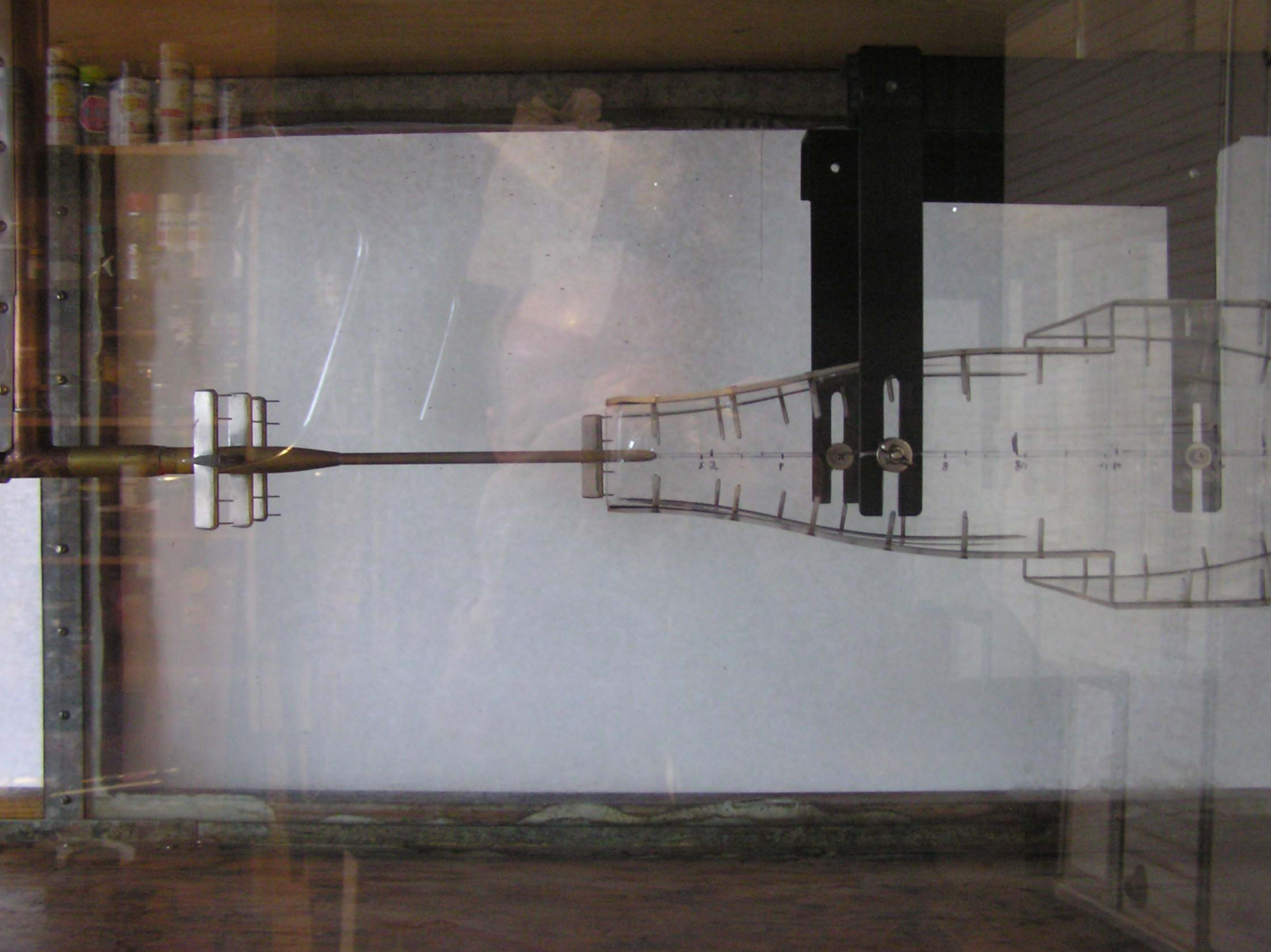
Chamber 3

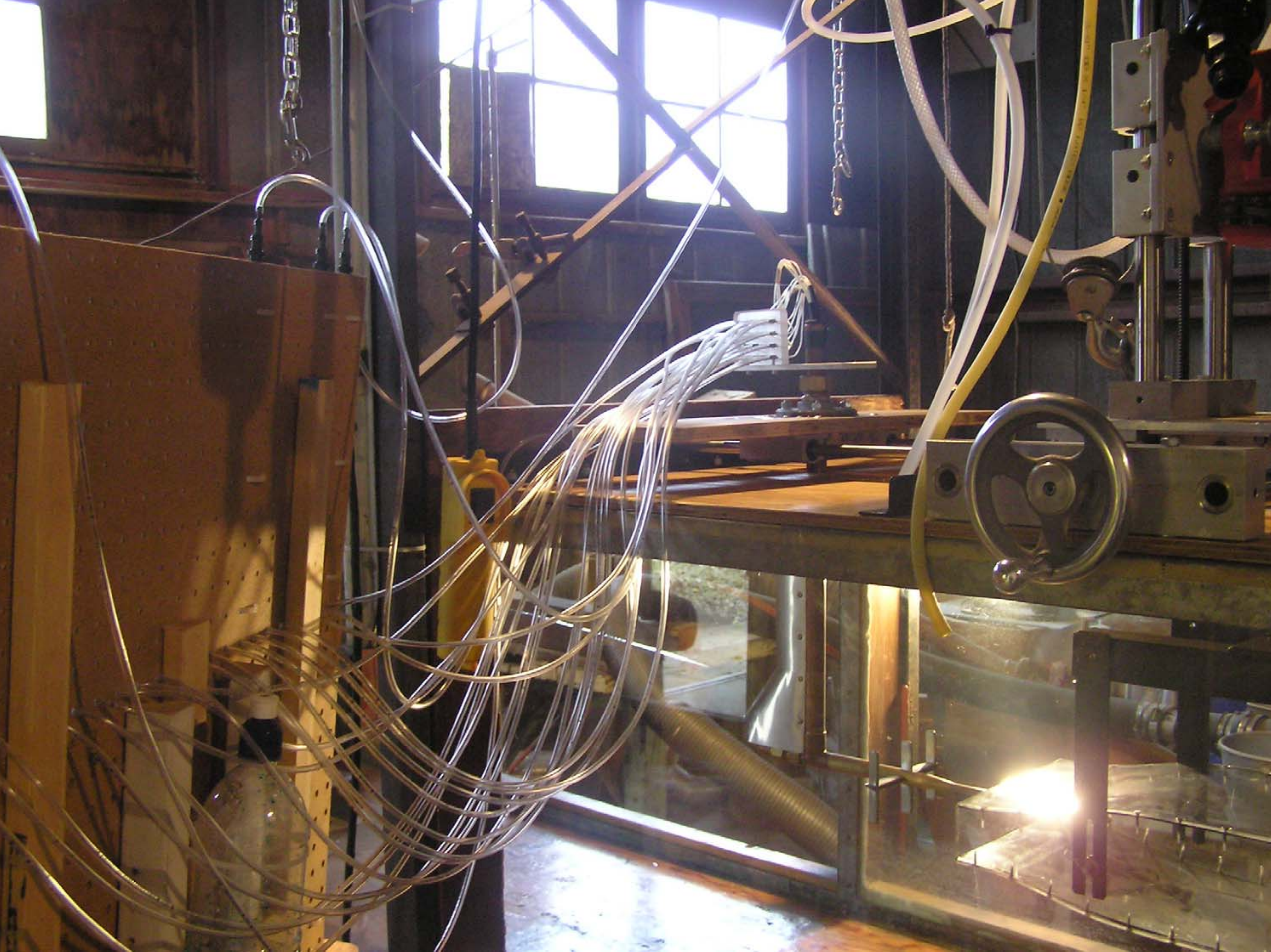
Air flow →

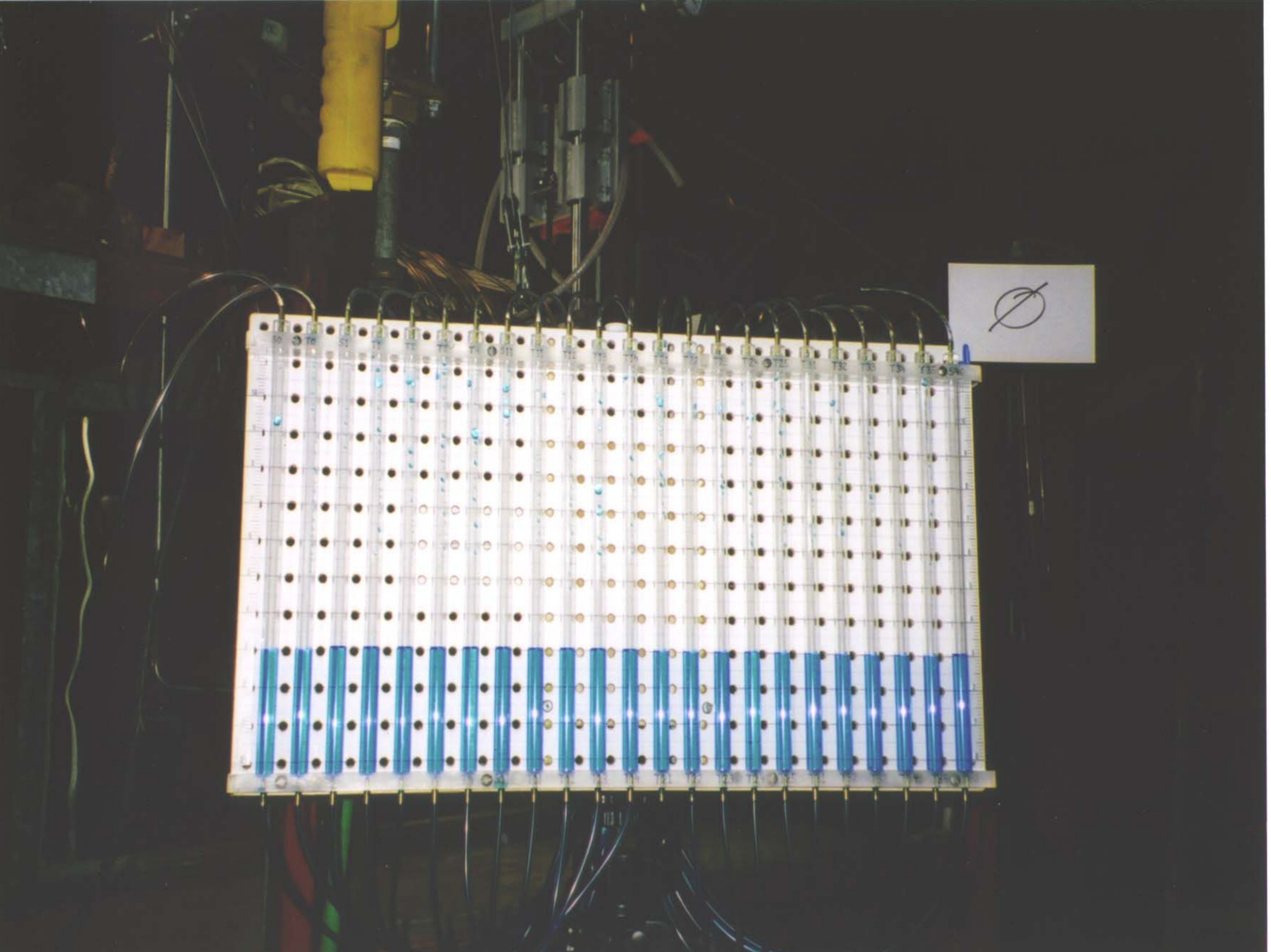


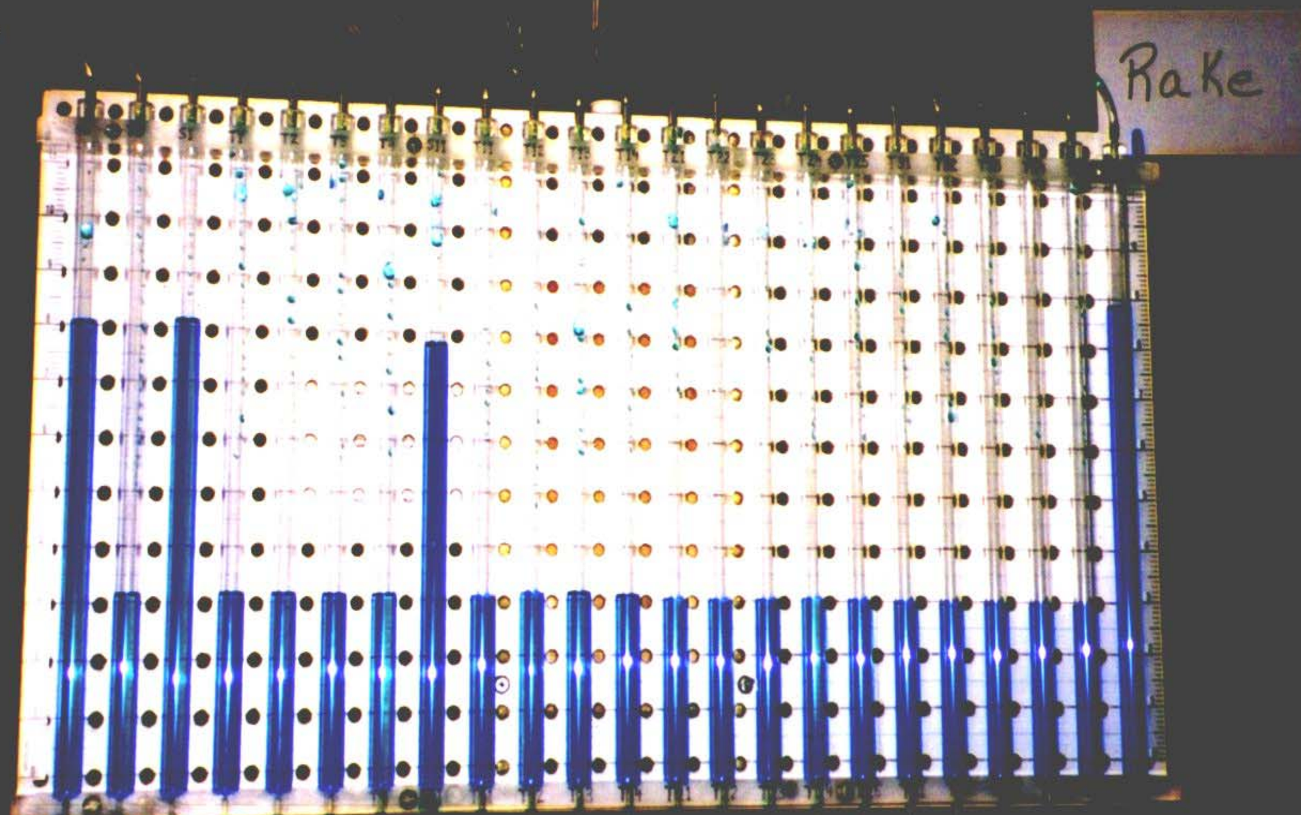
Reverse Venturi Atomization Chambers

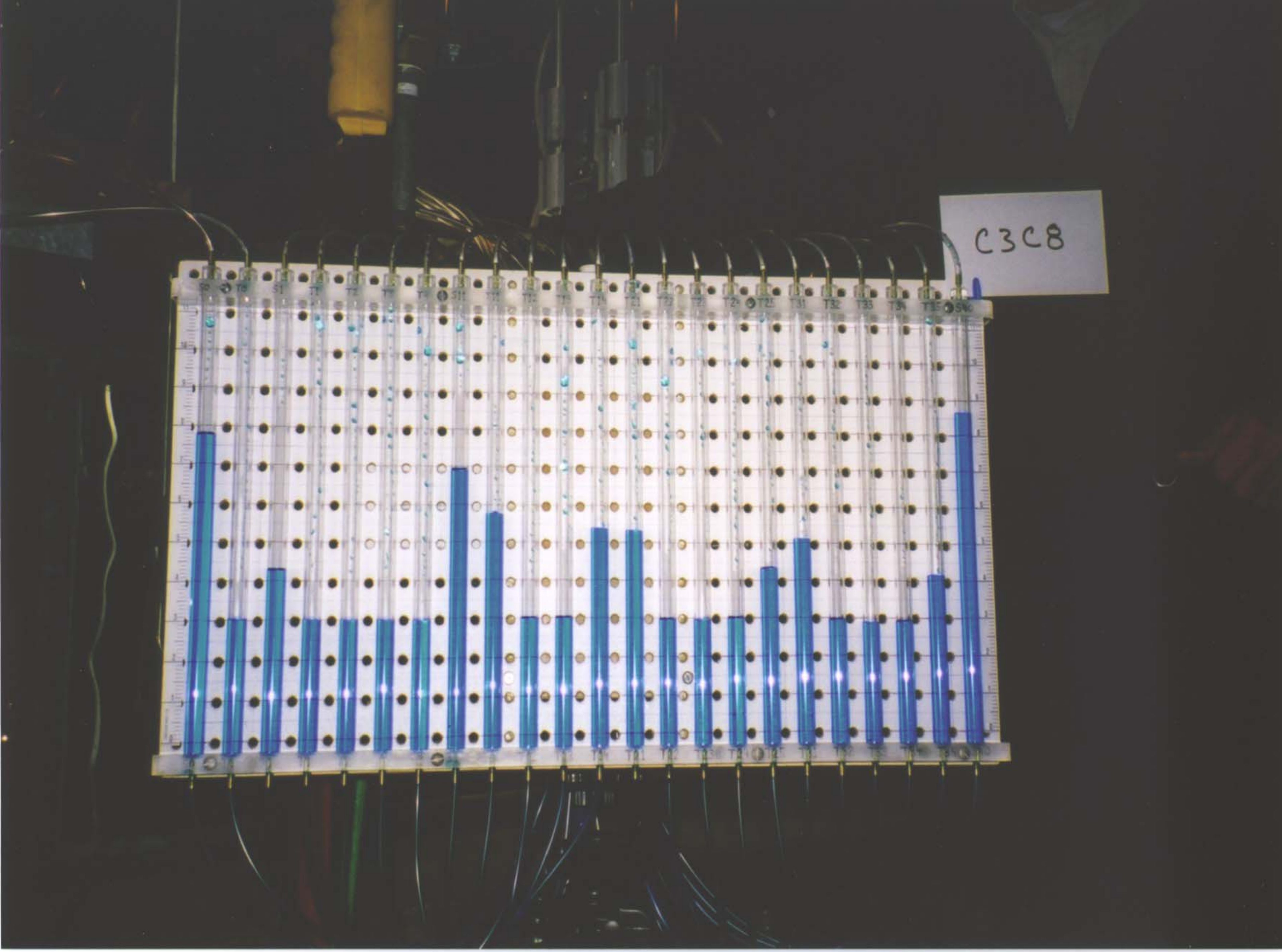

WISCONSIN

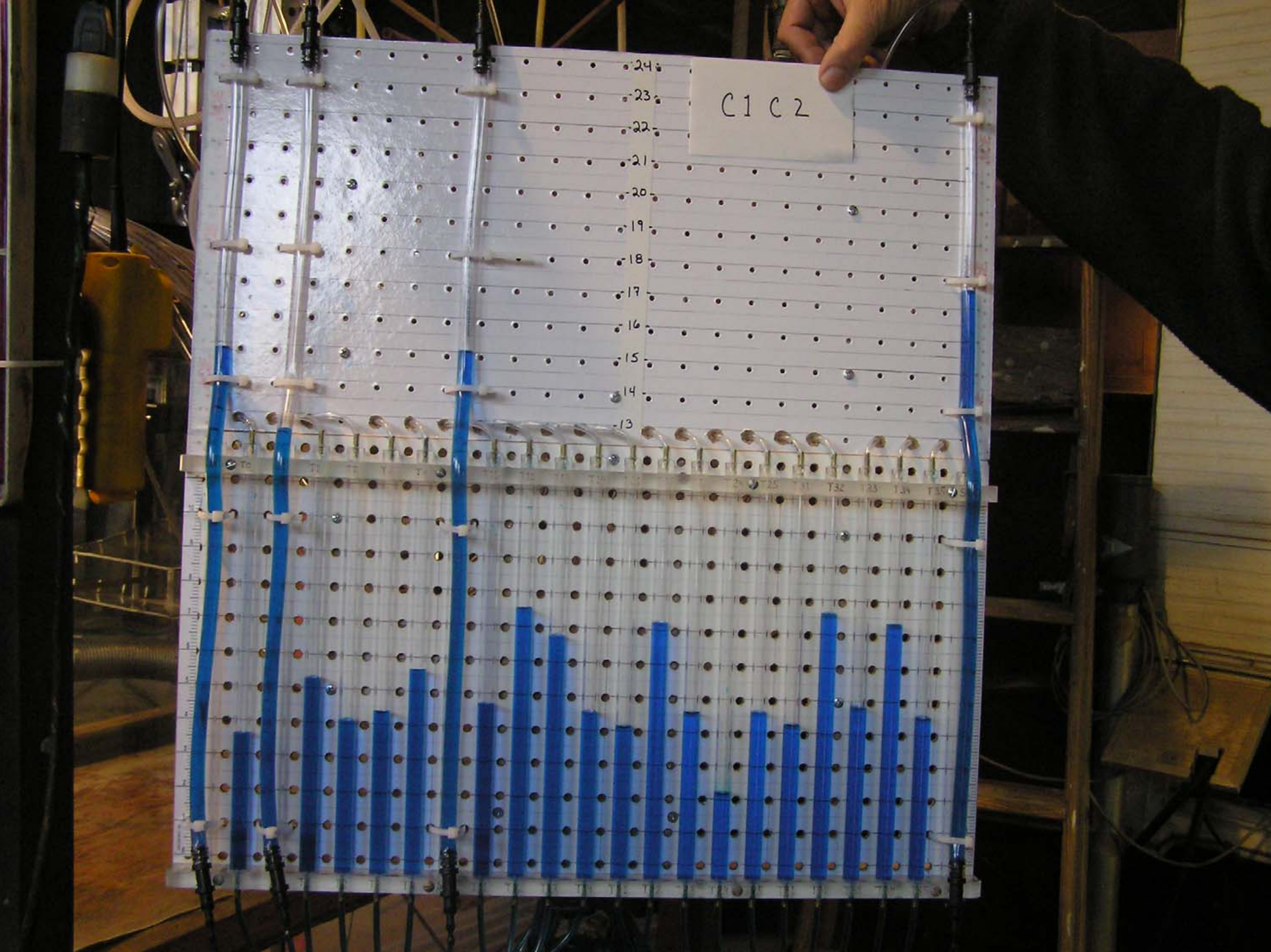







Rake


C3C8



C1 C2
24
23
22
21
20
19
18
17
16
15
14
13

TABLE 2. Pressure Survey Rake (PSR) results
PSR readings, in mph, from the four tubes (T_1 - T_4, in horizontal orientation) at five points, in two inch increments, from the chamber exit (0") into the mid-section (8" from the exit) of the RVA chamber while mounted in the wind tunnel; wind at ≈100 mph and 150 mph.

Chamber 1	**100 mph**					**150 mph**				
	0"	**2"**	**4"**	**6"**	**8"**	**0"**	**2"**	**4"**	**6"**	**8"**
$\mathbf{T_1}$	89.6	87.9	75.5	58.8	55.2	133.8	121.8	102.8	90.7	87.3
$\mathbf{T_2}$	94.0	92.4	79.4	63.8	58.8	143.3	131.5	109.5	93.5	88.5
$\mathbf{T_3}$	96.7	93.5	80.7	68.4	58.8	140.4	129.1	104.8	89.6	86.7
$\mathbf{T_4}$	91.3	87.9	80.0	69.1	57.0	131.8	118.9	93.0	78.8	79.4
0 $\mathbf{T_{1-}}$ $\mathbf{T_4}$	92.9	90.4	78.9	65.0	57.5	137.3	125.3	102.5	88.2	85.5

TABLE 2. Pressure Survey Rake (PSR) results

PSR readings, in mph, from the four tubes (T_1 - T_4, in horizontal orientation) at five points, in two inch increments, from the chamber exit (0") into the mid-section (8" from the exit) of the RVA chamber while mounted in the wind tunnel; wind at ≈100 mph and 150 mph.

Chamber 3	**100 mph**					**150 mph**				
	0"	**2"**	**4"**	**6"**	**8"**	**0"**	**2"**	**4"**	**6"**	**8"**
$\mathbf{T_1}$	95.7	88.5	73.4	58.8	51.4	143	130	100	86	76
$\mathbf{T_2}$	95.7	88.5	73.4	58.8	51.4	143	130	100	86	76
$\mathbf{T_3}$	95.7	88.5	73.4	58.8	51.4	143	130	100	86	76
$\mathbf{T_4}$	95.7	88.5	73.4	58.8	51.4	143	130	100	86	76
0 $\mathbf{T_{1-}}$ $\mathbf{T_4}$	95.7	88.5	73.4	58.8	51.4	143	130	100	86	76

Nozzles Tested:

H1/8VV-2505, Spraying Systems Co., Wheaton IL.

1/8MEG-1503, Spraying Systems Co., Wheaton, IL

D-5, Spraying Systems Co., Wheaton, IL.

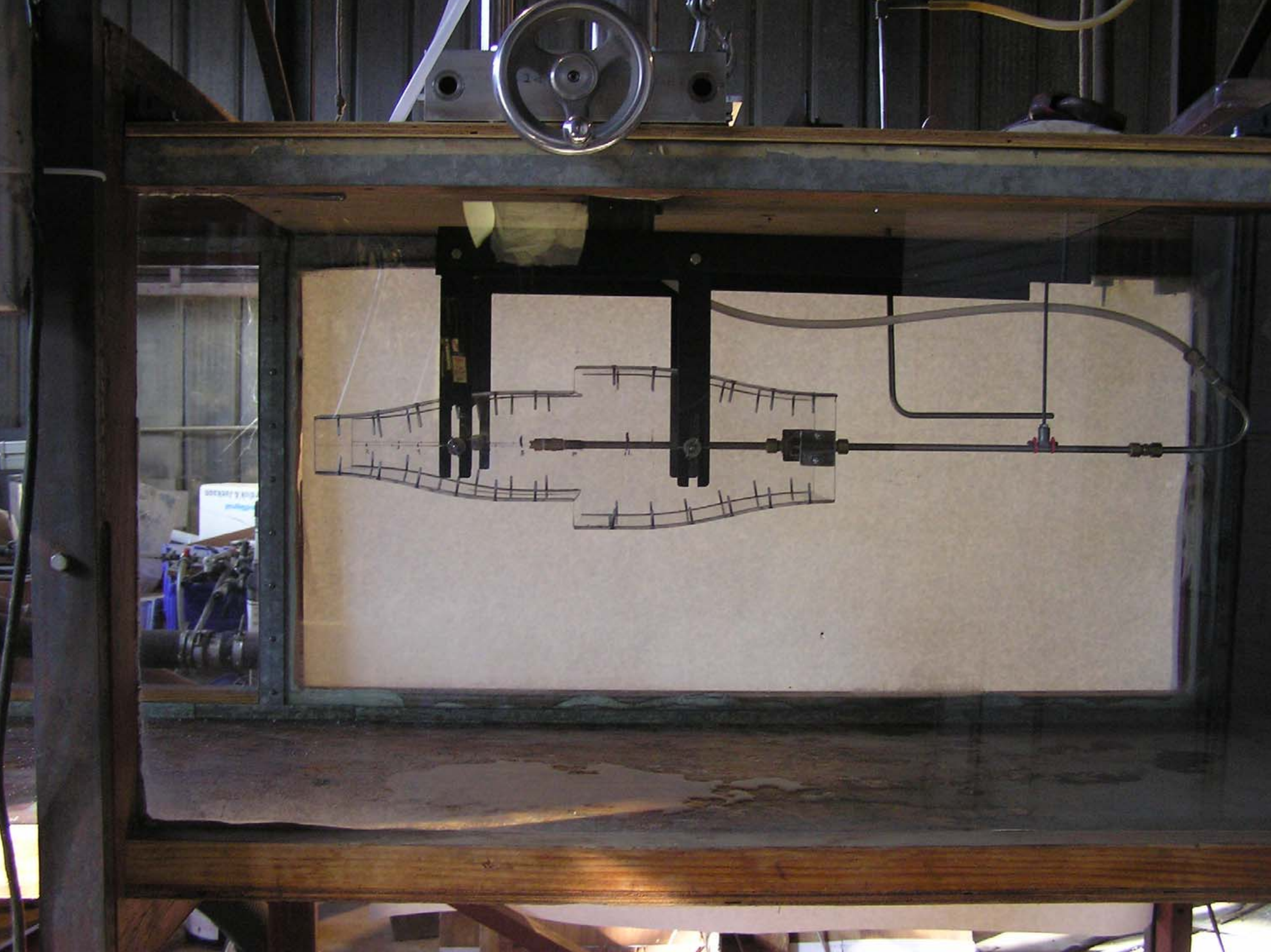
Microfoil .013, Bishop Equipment Mfg., Hatfield, PA.

H1/8VV-0003, Spraying Systems Co., Wheaton, IL.

H1/8VV-1505, Spraying Systems Co., Wheaton, IL.

Monarch, H-535 #.60-15, Monarch Nozzle Co., Pleasantville, NJ.

TubeJet .0625, a custom-made nozzle, .0625" ID, 2" long tube.



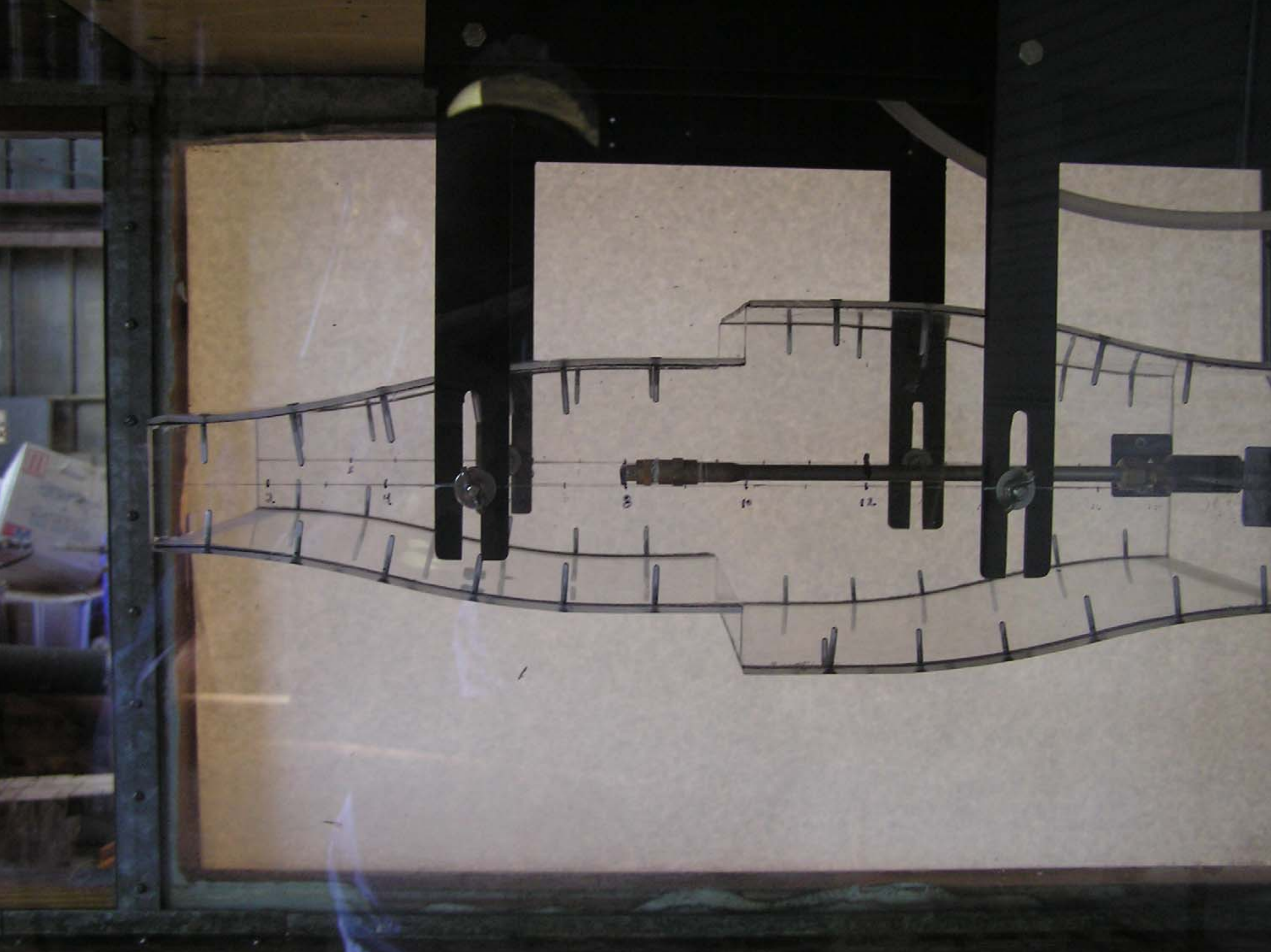
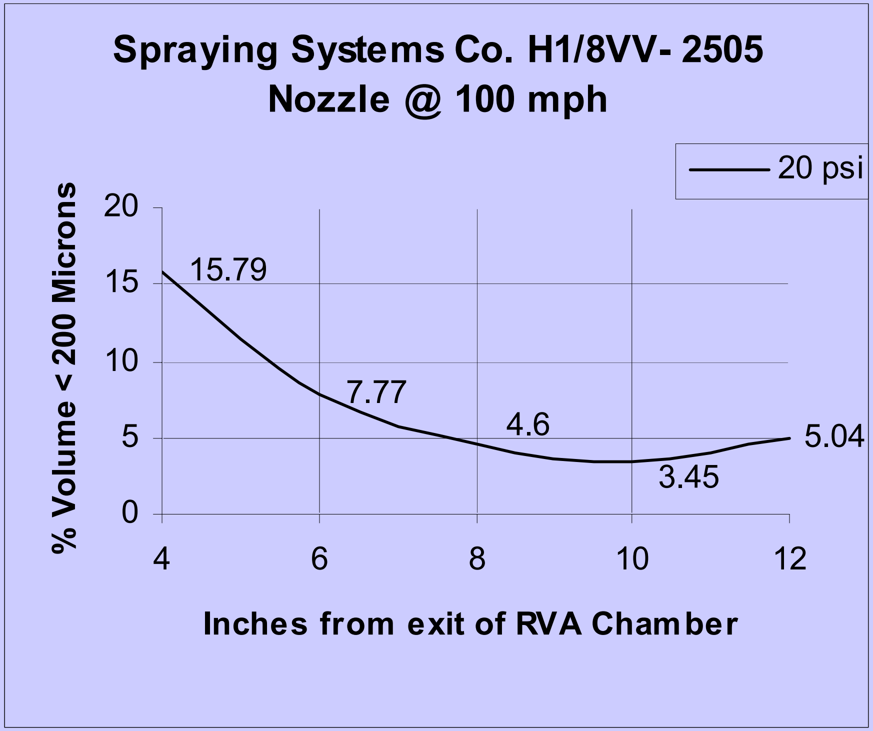


Figure 4
Graphical representation of % volume < 200 μ (fines) produced by all eight nozzles tested, using water, in the RVA chamber at 100 and 150 mph. One nozzle was run at 5 psi and the others at both 20 and 50 psi (with one exception, see below). Nozzles were tested from 4 to 12 inches from the exit of the chamber, in 2 inch increments, along the center axis of the chamber. Note that to display the curves well, the y-axes are not consistent between the various nozzles.



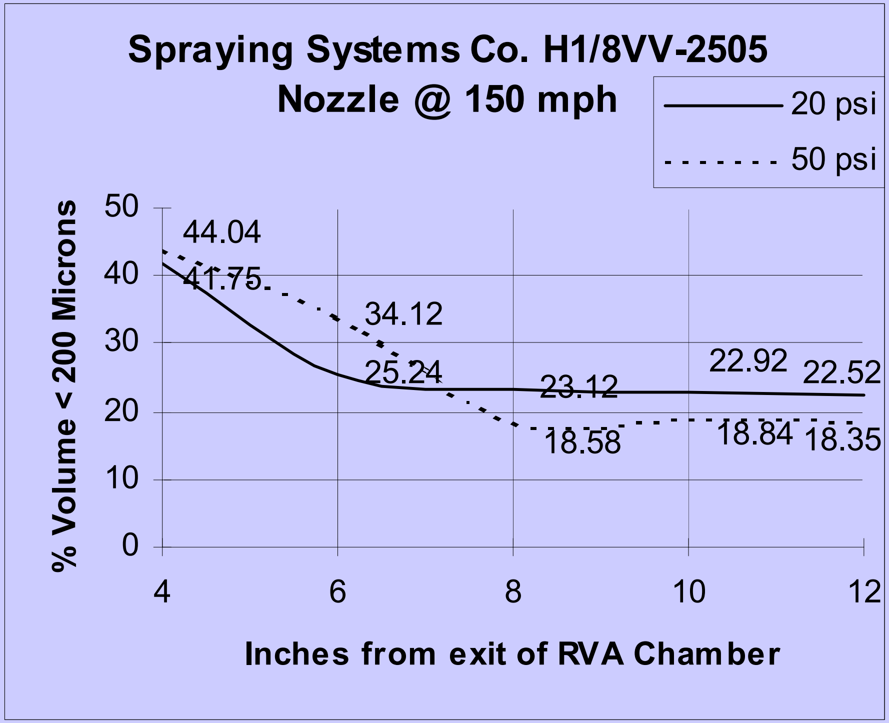
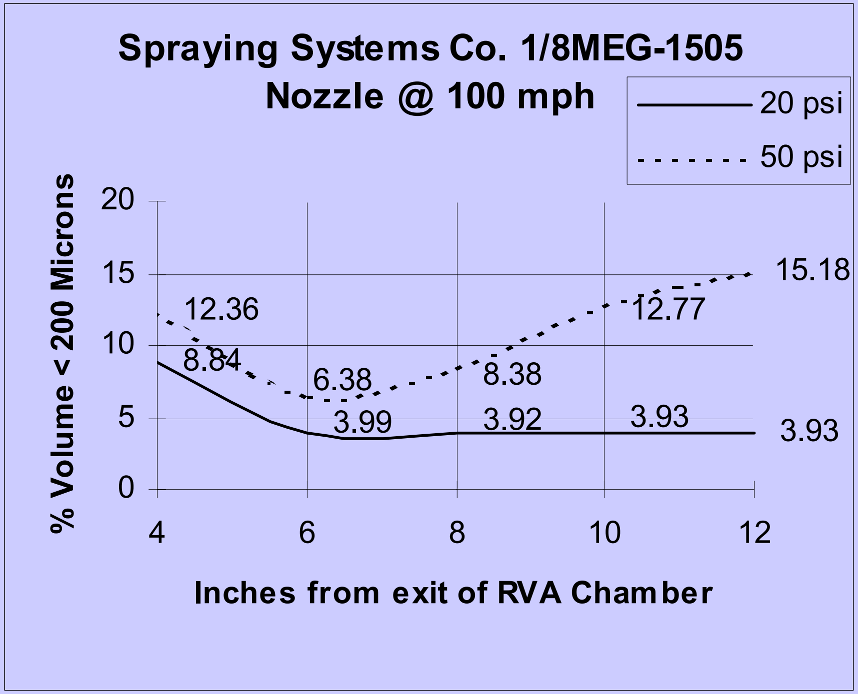


Figure 4
Graphical representation of % volume < 200 μ (fines) produced by all eight nozzles tested, using water, in the RVA chamber at 100 and 150 mph. One nozzle was run at 5 psi and the others at both 20 and 50 psi (with one exception, see below). Nozzles were tested from 4 to 12 inches from the exit of the chamber, in 2 inch increments, along the center axis of the chamber. Note that to display the curves well, the y-axes are not consistent between the various nozzles.



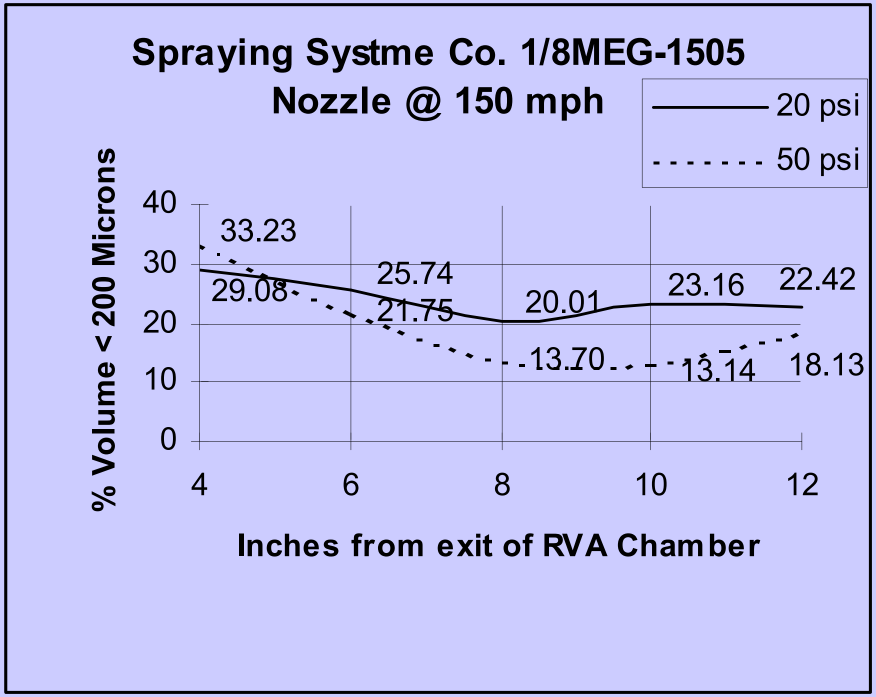
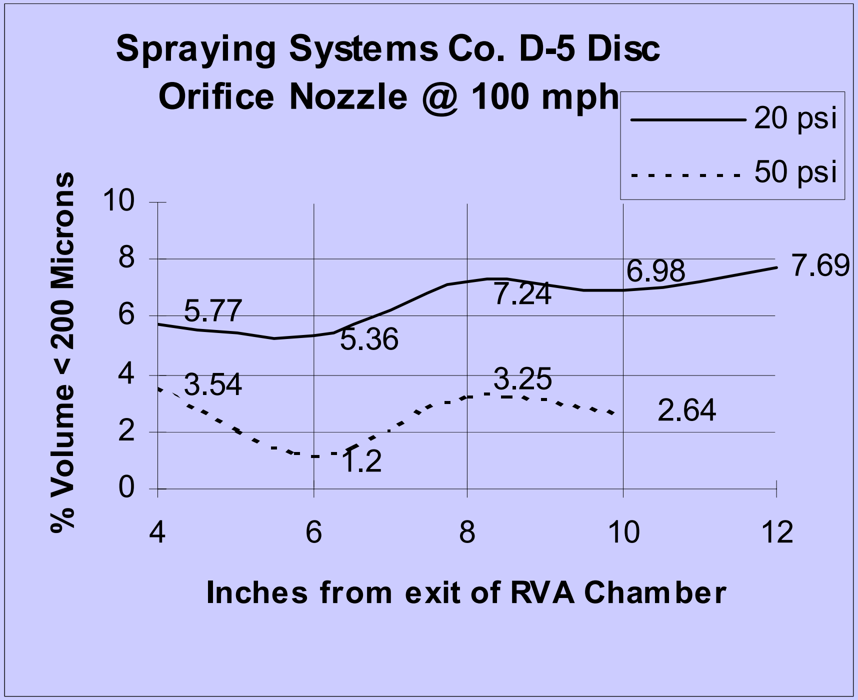


Figure 4

Graphical representation of % volume < 200 μ (fines) produced by all eight nozzles tested, using water, in the RVA chamber at 100 and 150 mph. One nozzle was run at 5 psi and the others at both 20 and 50 psi (with one exception, see below). Nozzles were tested from 4 to 12 inches from the exit of the chamber, in 2 inch increments, along the center axis of the chamber. Note that to display the curves well, the y-axes are not consistent between the various nozzles.



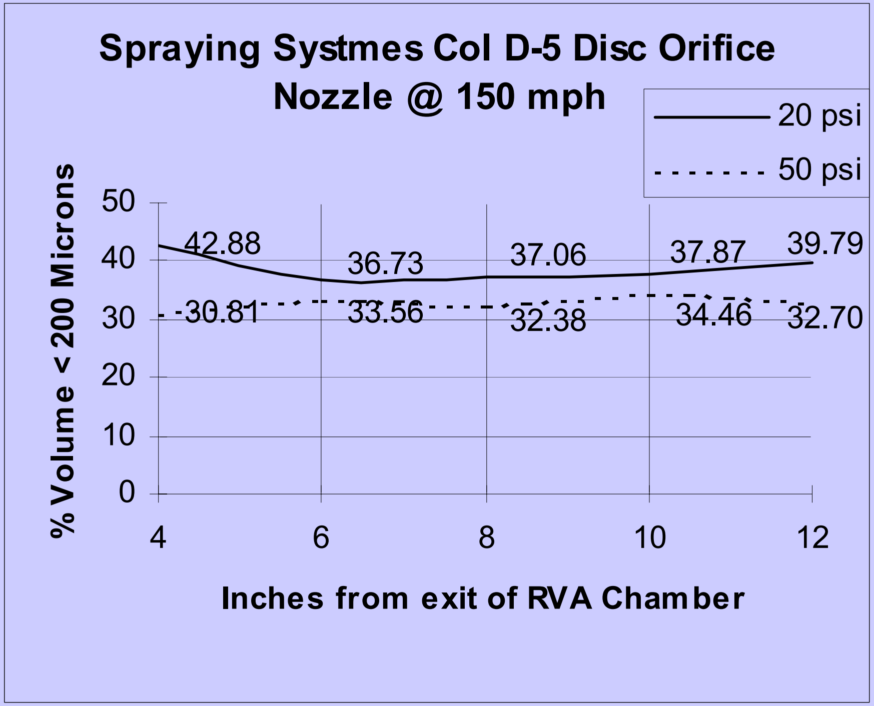
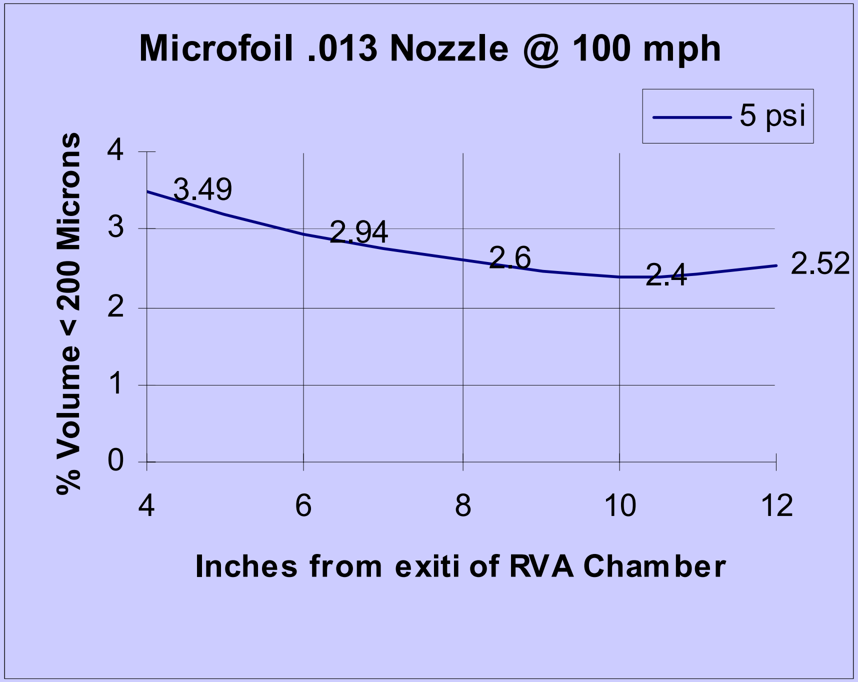


Figure 4

Graphical representation of % volume < 200 μ (fines) produced by all eight nozzles tested, using water, in the RVA chamber at 100 and 150 mph. One nozzle was run at 5 psi and the others at both 20 and 50 psi (with one exception, see below). Nozzles were tested from 4 to 12 inches from the exit of the chamber, in 2 inch increments, along the center axis of the chamber. Note that to display the curves well, the y-axes are not consistent between the various nozzles.



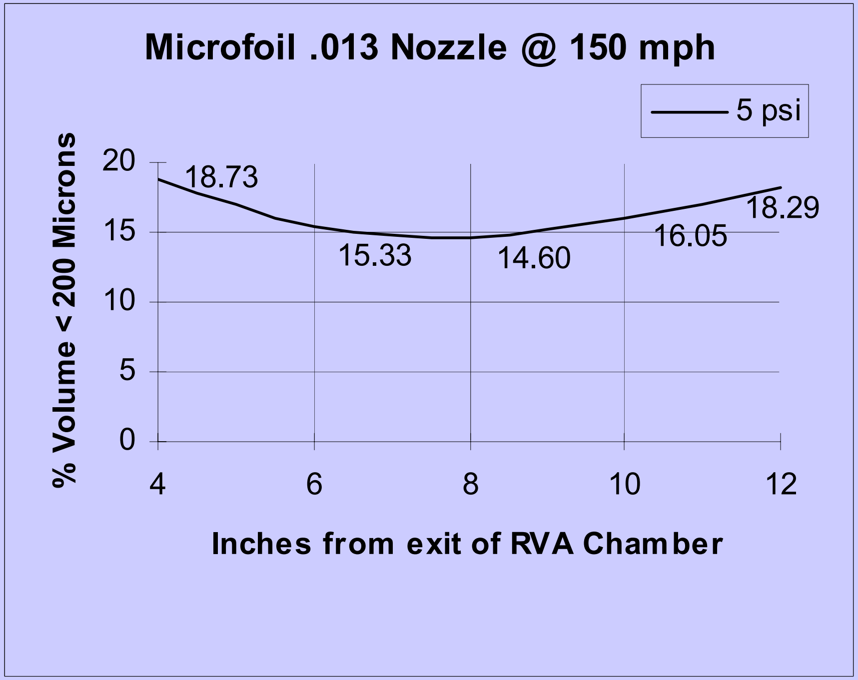
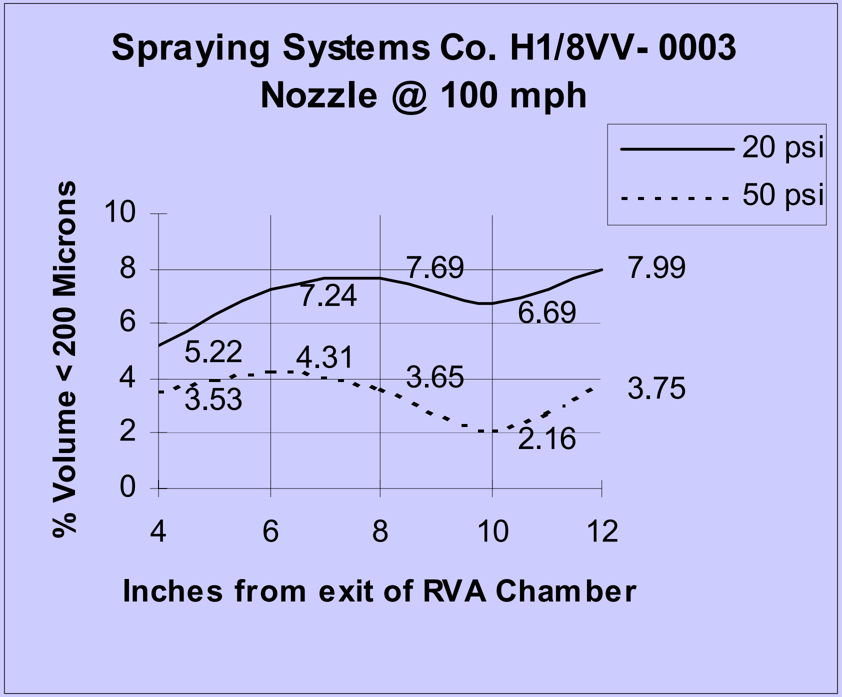


Figure 4

Graphical representation of % volume < 200 μ (fines) produced by all eight nozzles tested, using water, in the RVA chamber at 100 and 150 mph. One nozzle was run at 5 psi and the others at both 20 and 50 psi (with one exception, see below). Nozzles were tested from 4 to 12 inches from the exit of the chamber, in 2 inch increments, along the center axis of the chamber. Note that to display the curves well, the y-axes are not consistent between the various nozzles.



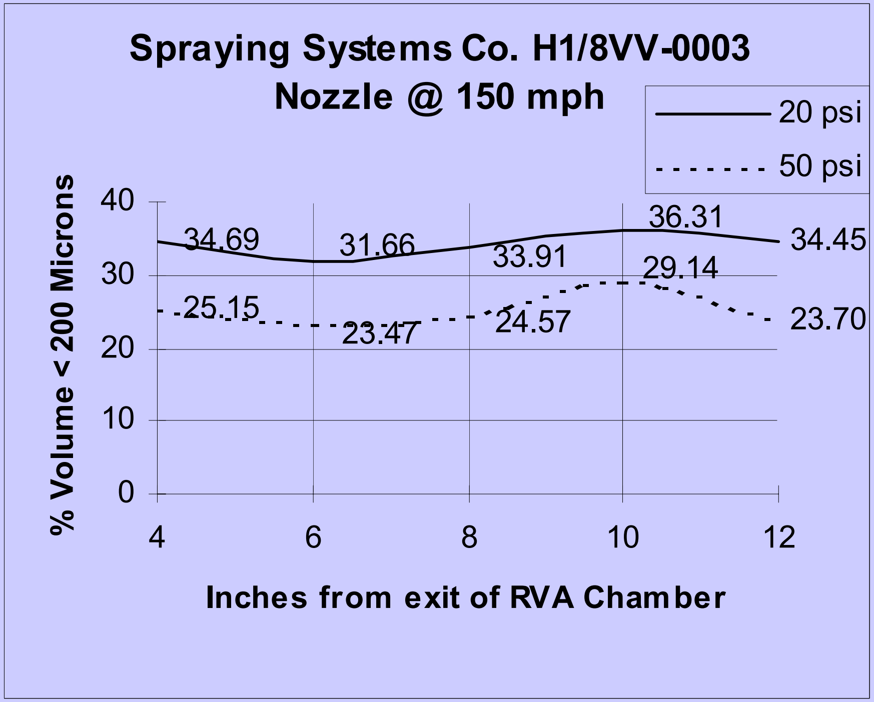
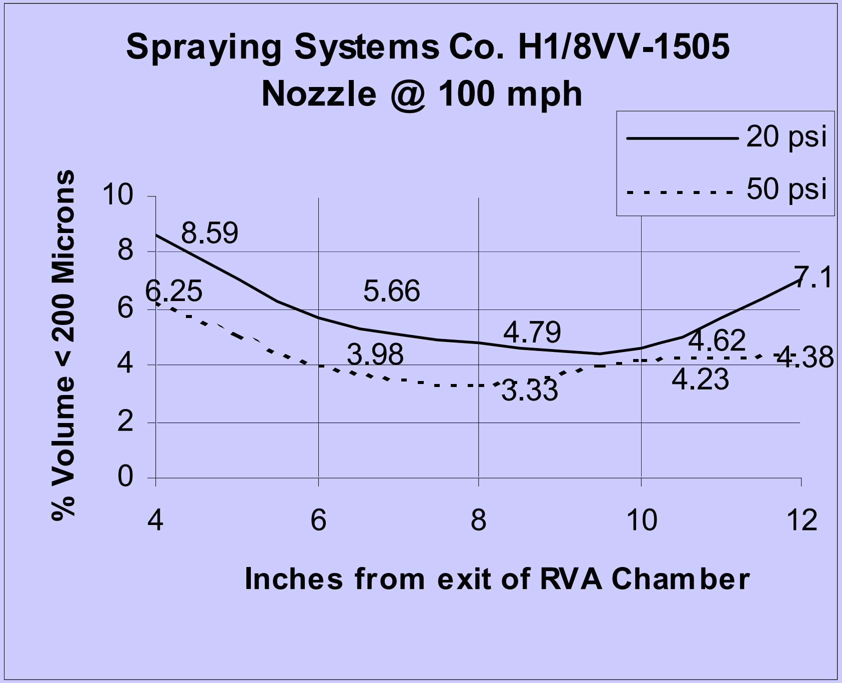


Figure 4

Graphical representation of % volume < 200 μ (fines) produced by all eight nozzles tested, using water, in the RVA chamber at 100 and 150 mph. One nozzle was run at 5 psi and the others at both 20 and 50 psi (with one exception, see below). Nozzles were tested from 4 to 12 inches from the exit of the chamber, in 2 inch increments, along the center axis of the chamber. Note that to display the curves well, the y-axes are not consistent between the various nozzles.



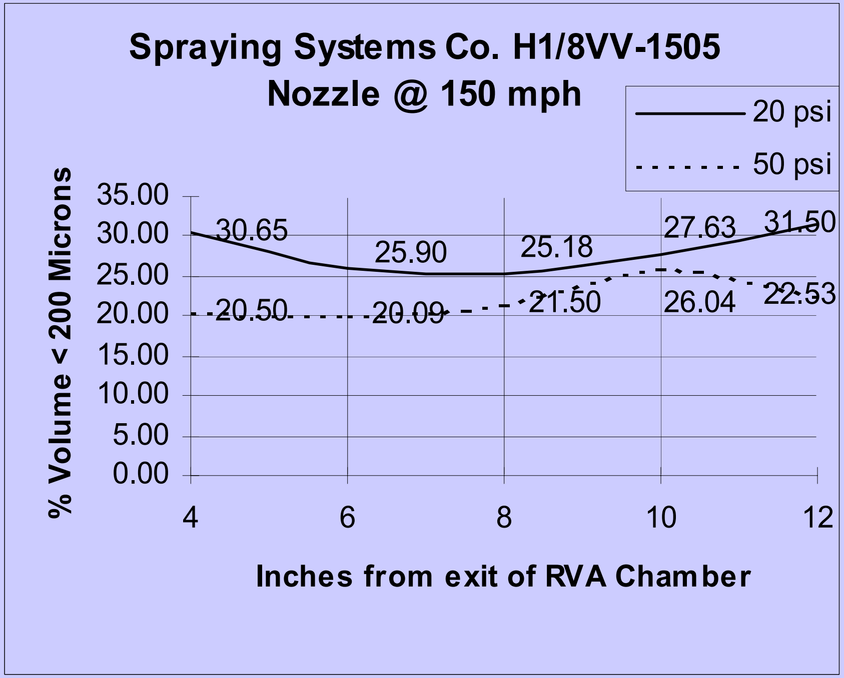
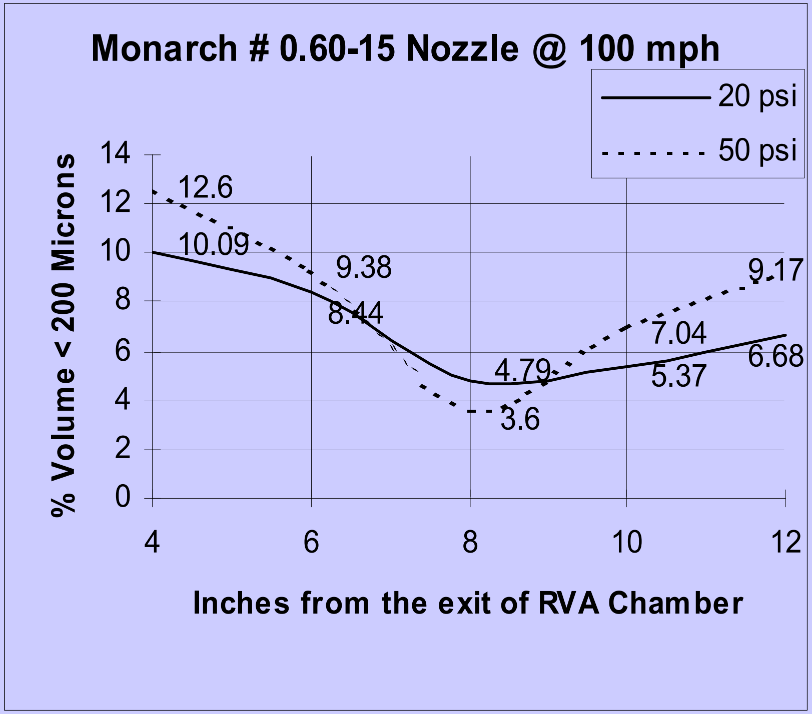


Figure 4

Graphical representation of % volume < 200 μ (fines) produced by all eight nozzles tested, using water, in the RVA chamber at 100 and 150 mph. One nozzle was run at 5 psi and the others at both 20 and 50 psi (with one exception, see below). Nozzles were tested from 4 to 12 inches from the exit of the chamber, in 2 inch increments, along the center axis of the chamber. Note that to display the curves well, the y-axes are not consistent between the various nozzles.



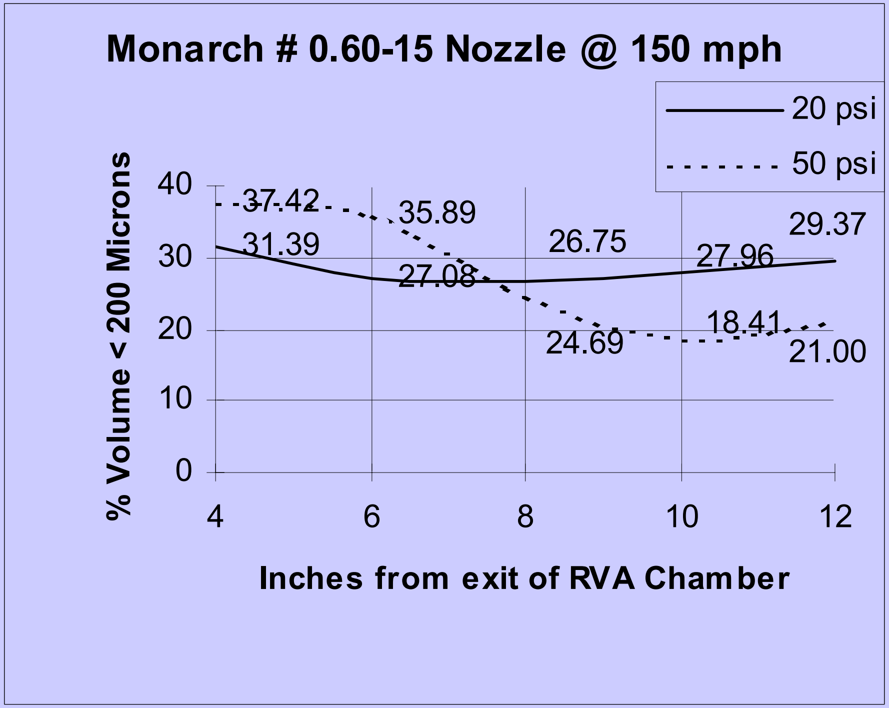
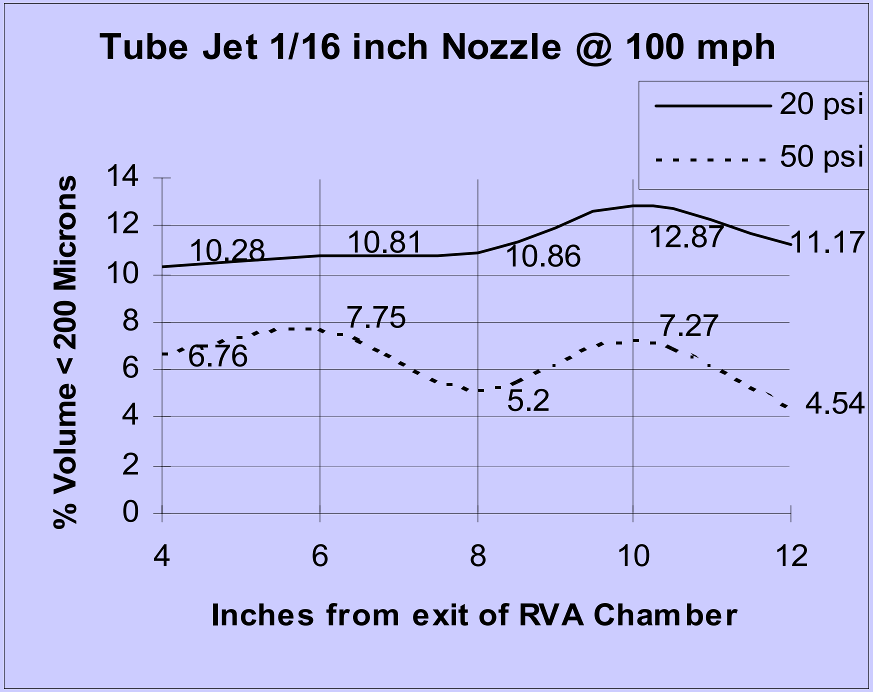


Figure 4

Graphical representation of % volume < 200 μ (fines) produced by all eight nozzles tested, using water, in the RVA chamber at 100 and 150 mph. One nozzle was run at 5 psi and the others at both 20 and 50 psi (with one exception, see below). Nozzles were tested from 4 to 12 inches from the exit of the chamber, in 2 inch increments, along the center axis of the chamber. Note that to display the curves well, the y-axes are not consistent between the various nozzles.



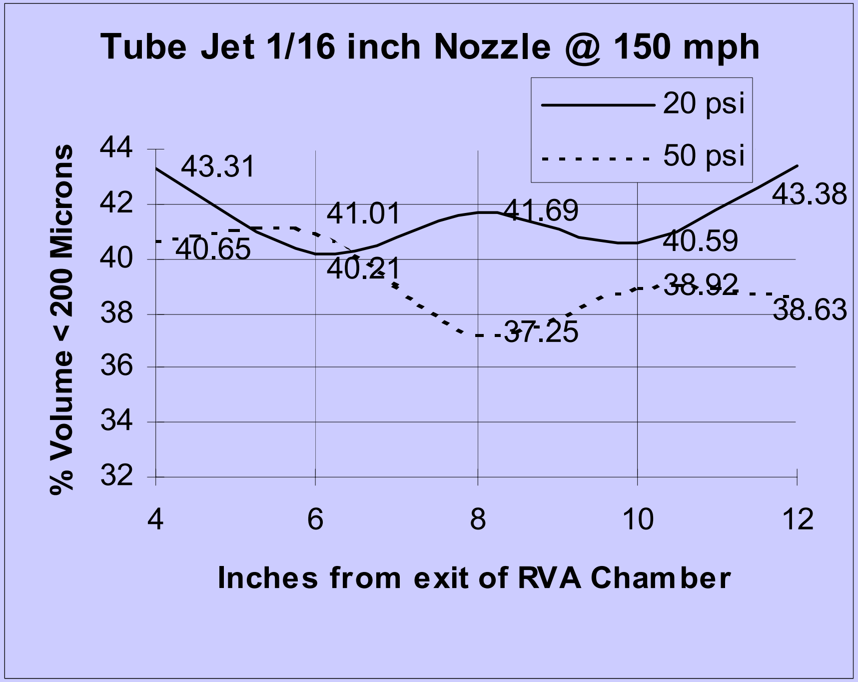


TABLE 5. Spray droplet comparisons of eight nozzles tested in the wind tunnel. Data represent the average of three tests on each nozzle at 50 and 100 mph. Spray pressures vary, as described in the text. Percent reduction in fines is between the nozzle alone at 100 mph and the nozzle in the RVA chamber at 100 mph in the wind tunnel.

Nozzle	Air Velocity (mph)	Liquid pressure (psi)	Droplet Size Indicators			% of volume <200µ	R.S.	% ↓ in fines
			Dv 0.1	Dv 0.5	Dv 0.9			
H1/8VV-2505	50	20	554	963	1419	2.32	0.89	
H1/8VV-2505	100	20	172	577	908	13.16	1.30	73.8%
H1/8VV-2505+RVA	100	20	508	924	1311	3.45	0.87	

TABLE 6. Spray droplet comparisons of eight nozzles tested in the wind tunnel. Data represent the average of three tests on each nozzle at 75 and 150 mph. Spray pressures vary, as described in the text. Percent reduction in fines is between the nozzle alone at 150 mph and the nozzle in the RVA chamber at 150 mph in the wind tunnel.

Nozzle model	**Air Velocity (mph)**	**Liquid pressure (psi)**	**Droplet Size Indicators**			**% of volume <200μ**	**R.S.**	**% ↓ in fines**
			Dv 0.1	**Dv 0.5**	**Dv 0.9**			
H1/8VV-2505	75	50	301	652	975	6.52	1.03	
H1/8VV-2505	150	50	55	330	617	30.67	1.71	39.4%
H1/8VV-2505+RVA	150	50	79	479	717	18.58	1.34	

Nozzle	Air Velocity (mph)	Liquid pressure (psi)	Droplet Size Indicators			% of volume <200µ	R.S.	% ↓ in fines
			Dv 0.1	Dv 0.5	Dv 0.9			
H1/8VV-2505	50	20	554	963	1419	2.32	0.89	
H1/8VV-2505	100	20	172	577	908	13.16	1.30	73.8%
H1/8VV-2505+RVA	100	20	508	924	1311	3.45	0.87	
1/8MEG-1503	50	20	577	952	1346	2.40	0.81	
1/8MEG-1503	100	20	143	533	943	13.67	1.50	71.3%
1/8MEG-1503+RVA	100	20	484	920	1179	3.93	0.75	
D-5	50	50	877	1552	1993	2.09	0.78	
D-5	100	50	590	1549	1995	3.18	0.95	62.3%
D-5+RVA	100	50	958	1904	2026	1.20	0.56	
Microfoil .013	50	5	603	751	928	1.89	0.43	
Microfoil .013	100	5	463	732	907	4.14	0.61	42.0%
Microfoil .013+RVA	100	5	656	846	1021	2.40	0.43	
H1/8VV-0003	50	50	1242	1914	1997	2.14	0.40	
H1/8VV-0003	100	50	550	1504	1865	3.44	0.91	37.2%
H1/8VV-0003+RVA	100	50	928	1857	2019	2.16	0.59	
H1/8VV-1505	50	50	461	884	1289	4.21	0.94	
H1/8VV-1505	100	50	325	717	1094	4.92	1.07	32.3%
H1/8VV-1505+RVA	100	50	492	893	1293	3.33	0.90	
Monarch H-535#.60-15	50	50	340	780	1237	5.98	1.15	
Monarch H-535#.60-15	100	50	310	684	1128	5.02	1.19	28.3%
Monarch+RVA	100	50	410	828	1405	3.60	1.19	
TubeJet .06256	50	50	905	1771	1888	2.77	0.56	
TubeJet .0625	100	50	351	1004	1768	5.77	1.44	21.3%
TubeJet .0625	100	50	448	1329	1948	4.54	1.18	

Nozzle model	Air Velocity (mph)	Liquid pressure (psi)	Droplet Size Indicators			% of volume <200μ	R.S.	% ↓ in fines
			Dv 0.1	Dv 0.5	Dv 0.9			
H1/8VV-2505	75	50	301	652	975	6.52	1.03	
H1/8VV-2505	150	50	55	330	617	30.67	1.71	39.4%
H1/8VV-2505+RVA	150	50	79	479	717	18.58	1.34	
1/8MEG-1503	75	50	206	476	708	9.70	1.06	
1/8MEG-1503	150	50	56	310	567	31.71	1.65	58.6%
1/8MEG-1503+RVA	150	50	123	503	732	13.14	1.21	
D-5	75	50	386	1124	1657	7.93	1.13	
D-5	150	50	45	369	746	32.87	1.92	1.5 %
D-5+RVA	150	50	44	480	929	32.38	1.83	
Microfoil .013	75	5	476	664	847	3.58	.56	
Microfoil .013	150	5	51	270	477	34.20	1.47	55.2%
Microfoil .013+RVA	150	5	96	510	696	15.33	1.18	
H1/8VV-0003	75	50	1555	1787	1980	0.35	0.24	
H1/8VV-0003	150	50	71	467	739	19.50	1.43	-17.0%
H1/8VV-0003+RVA	150	50	55	504	847	23.47	1.57	
H1/8VV-1505	75	50	429	826	1173	6.89	.90	
H1/8VV-1505	150	50	55	372	619	25.49	1.52	21.2%
H1/8VV-1505+RVA	150	50	70	491	755	20.09	1.40	
Monarch H-535#.60-15	75	50	274	698	1051	7.89	1.11	
Monarch H-535#.60-15	150	50	58	342	592	26.92	1.56	31.6%
Monarch+RVA	150	50	73	516	781	18.41	1.37	
TubeJet .06256	75	50	205	1217	1646	10.43	1.20	
TubeJet .0625	150	50	48	307	710	35.77	2.14	-4.1%
TubeJet .0625	150	50	42	348	755	37.25	2.05	

Additional Points

- Future Design
  - Size
  - Shape
- Drag
- Angle of Attack
- Flow Rate Control

Thank You


N8347K


N8347K

Reducing Driftable Fines in Aerial Application of Pesticides – A Reverse Venturi Atomization Chamber

By

Russ Stocker

Norman Akesson

William Peschel

Reducing Driftable Fines in Aerial Application of Pesticides – A Reverse Venturi Atomization Chamber

By

Russ Stocker

Norman Akesson

William Peschel